1998 Ontario Studies In Determining The Genetic Stability, Environment And Latitude Effect On The Levels Of delta-9 THC For Industrial Hemp Varieties

March, 1999

Gordon Scheifele (Thunder Bay), Herb Hinz(Thunder Bay), Karen Davies (Thunder Bay), Kim-Jo Bliss Calder (Emo), Matt Bowman (New Liskeard), Kemptville College/University of Guelph, Thunder Bay Agricultural Research Station, Thunder Bay, Ontario. Laurier Guillemette, Kapuskasing Agriculture Research Station, Agriculture and Agri-Food Canada, Kapuskasing, Ontario.

Table of Contents

1. Executive Summary
2. Introduction
3. Objectives
4. Project Outline
5. Results and Discussion
6. Conclusions
7. Acknowledgments and References
8. For more information...

Executive Summary

Introduction. THC (*delta-9* tetrahydrocannabinol) is the classified psycho-active ingredient in *Cannabis sativa* and is produced in lesser or greater quantities in *Cannabis sativa* and hemp varieties. Hemp varieties have been bred for low THC content since the 1970s. The European Community and Canada have adopted the 0.3% THC level as the restricted legal limit for hemp varieties. Previous European and Canadian research has identified soil fertility, soil type and stress to effect the THC content within a variety. Higher latitudes and altitudes have also been shown to reduce THC levels in eastern European research. Two monoecious Romanian industrial hemp varieties, Secuieni 1 and Irene, were conditionally granted permission to be grown in Canada in 1998 by Health Canada due to their tendencies to exceed the legal limits for THC content in Canada in 1996 and 1997. Health Canada required additional THC sampling for these two varieties 50 days post emergence plus the regular sampling at 50% pollen shedding to verify their genetic stability and response to the environment for consistently remaining below the 0.3% THC legal limit.

Project Outline. The hemp varieties Secuieni 1, Irene, Fedora 19, Felina 34, Fedrina 74, Unico B and Kompolti were planted at 32 sites (2 hectares strip trials at each site) across northern Ontario for fibre and grain production studies: Manitoulin Is. (2), Sudbury (3), Verner (3), Thunder Bay (7), Dryden (5), Rainy River (10) Kapuskasing (1) and New Liskeard (1). Tissue samples were harvested from Secuieni 1 and Irene at 50 days post emergence and at 50% pollen shedding for all varieties. Results of THC analysis were obtained from southern and eastern Ontario and southwestern Quebec and were summarized with those from northern Ontario to further characterize variety genetic stability and response to the environment. Five varieties (Kompolti Hybrid TC, Secuieni 1, Irene, Kompolti and Unico B) were evaluated at 5 different latitudes to further verify latitude effect on THC content. Efforts were made to identify altitude effect on THC levels.

Results and Discussion. Secuieni and Irene, sampled at 50 days post emergence gave a range of values from 0.05 to 0.33 and 0.05 to 0.40% THC respectively and overall means of 0.16 and 0.15% THC

respectively over 30 sites in northern Ontario sampled at 50 days post emergence. Both varieties exceeded the legal limits on two sites in the Dryden regions. Regression analysis identified relatively strong genetic stability (R^2 = 76.0 & 80.4 respectively) for both varieties. They both responded strongly and similarly to their environments (slopes = 0.94 & 1.06 respectively). The environmental means ranged from 0.07 to 0.23% THC. The response of both varieties to their environments (steep slope) and their relatively strong genetic stability (high R^2) were strong enough to provide each the potential tendency to exceed the 0.3% THC legal limit given the appropriate contributing environmental conditions.

The THC data collected at 50% pollen shedding from northern, southwest and southeastern Ontario and southwest Quebec were summarized and evaluated. Regression analysis was completed for only the northern Ontario data. The northern Ontario data characterized Felina 34, Kompolti, Fedora 19, Fedrina 74, Unico B, Irene and Secuieni with over all means and range of values: 0.08 (0.03-0.16), 0.09 (0.03-0.23), 0.11 (0.05-0.25), 0.08 (0.05-0.3), 0.11 (0.05-0.36), 0.16 (0.05-0.41) and 0.23 (0.05-0.53) respectively. Felina 34, Kompolti, Fedora19 and Fedrina 74 all demonstrated weak genetic stability (R^2 = 35.3, 30.2, 35.2 and 52.6 respectively) and Fedrina 74 having the stronger response to the environment (slope = 0.74; it reached 0.3% only once). Their low overall means and range of values demonstrated these varieties to be considered quite safe in not exceeding the legal THC limit. Unico B demonstrated a stronger genetic stability (R^2 = 63.1)and response to the environment (slope of 1.1) and did on rare occasions exceed the legal limit. Irene had the strongest genetic stability (R^2 = 68.1) and very strong response to the environment (slope of 1.6). It exceeded the legal limit 4 times in northern Ontario and none in other areas of the province and southwestern Quebec. Secuieni 1 demonstrated slightly less genetic stability (R^2 = 60.5) than Irene and gave the greatest response to the environment (slope of 1.9) exceeding the legal limit 8 times in both northern Ontario and southern Ontario. The correlation of THC levels between 50 days post emergence and 50% flowering for Secuieni 1 and Irene (r =25% and 15% respectively) indicated a very weak relationship for THC accumulation between these two stages of maturity. The 50 day post emergence sampling gave the lowest levels and is considered to have been unnecessary and should not be considered in the future. A preliminary statistical analysis demonstrated a highly significant genotype x environment interaction for these data.

The greatest acreage potential for industrial hemp production in Canada is considered to be north of the 46 th latitude. The 1998 Ontario data does support a latitude effect on reduction of THC levels at higher latitudes as a trend with exceptions. The magnitude of latitude change required before impacting a significant change in THC levels is not known. It is apparent that varieties will respond differently and many other environmental factors are involved. The effort to establish altitude effect on THC levels was confused by other environmental factors.

Conclusion. THC sampling in the future should be restricted to the stage of plant maturity defined as 50% flowering and pre seed maturation. Secuieni 1 and Irene demonstrated their abilities to exceed the 0.3% legal limits quite freely and should be considered unsafe for future Ontario and Canadian production in compliance with Health Canada regulations. Higher latitudes can reduce THC levels in hemp plants with varieties responding differently. **The strong highly significant genotype x environment interaction further complicates this association.** The agronomic research initiatives in Canada will be challenged to more completely understand the stress components which cause the hemp plant to produce higher levels of THC content. These unknown factors will continue to frustrate and complicate Canadian efforts to develop new varieties to remain consistently below the legal limit of 0.3% THC content and perform competitively for fibre and grain production. Based on the above information THC screening efforts in more southern latitudes such as southern Ontario would be expected to apply the greatest screening pressure on selection of genetic materials for consistent low percent THC levels. Such screened materials could then be further selected in the respective anticipated production regions for performance and local adaptation.

| Top of Page |

Introduction

The *delta-9* THC (*delta-9* tetrahydrocannabinol) is the classified psycho-active ingredient in *Cannabis sativa* and is produced in lesser or greater quantities in *Cannabis sativa* and hemp varieties. Hemp varieties have been bred for low THC content since the 1970s (Bocsa). The European Community and Canada have adopted the 0.3% THC level as the restricted legal level for hemp varieties. Selection of varieties in European and Canadian breeding programs for lower than 0.3% THC levels is a major primary selection criteria. The

role of THC in the development of the hemp plant is poorly understood and research efforts are being initiated to develop hemp varieties with absolutely no genetic ability to produce THC. Bocsa speculates that the development of zero THC plants is biologically inconceivable.

Research from Dr. Ivan Bocsa (Agriculture Research Institute, Kompolt, H-3356, Hungary), Peter Dragla (Ridgetown College/University of Guelph, Ridgetown, Ont., 1997) and Gordon Scheifele (Kemptville College/University of Guelph, Thunder Bay, Ont., 1996 & 1997) suggests that within a particular variety, the THC content can be influenced by environmental conditions such as soil type, fertility and stress. It has been observed that higher latitudes result in lower THC levels under certain conditions (Bocsa, Dragla and Scheifele). Bocsa also identified that higher altitudes will produce lower levels of THC. Establishing the effect of environment and higher latitude and altitude on lowering THC levels in industrial hemp varieties is a significant genotype x environment interaction effect potentially impacting the future of industrial hemp production in western and eastern Canada as well as in northern Ontario (areas with higher latitudes (over 46 ^{o})and altitudes) where potentially the largest acres of industrial hemp production will predominate.

Secuieni 1 and Irene were two monoecious Romanian industrial hemp varieties identified to have high stalk (fibre) and grain production potential in Ontario research trials in 1996 (Scheifele) and 1997 (Dragla) and these studies demonstrated these varieties exceeding the 0.3% THC legal limit on several occasions. Health Canada conditionally granted permission to grow these varieties in 1998 providing additional THC sampling and testing be done at 50 days post emergence and again at 50% flowering to verify their genetic stability and response to the environment for consistent less than 0.3% THC levels before granting consideration for approved future commercial production of these varieties in Canada.

| Top of Page |

Objectives

1. Attempt to further establish the genetic stability and response to the environment for low THC industrial hemp varieties, Secuieni 1 and Irene, for %THC levels in northern.
2. Attempt to establish the potential effect of higher latitude production areas on lowering %THC levels using the varieties Irene, Secuieni 1, Unico B, Kompolti and Kompolti Hybrid TC as models of industrial hemp grown from southern Ontario (lowest latitude: 42 ^{o} 25') to northern Ontario (highest latitude: 49 ^{o} 30').
3. To summarize %THC data collected in 1998 from across Ontario for Secuieni 1, Irene, Unico B, Kompolti, Fedora 19, Felina 34 and Fedrina 74 industrial hemp varieties and to characterize genetic stability and environmental reaction.

Funding

The funding for this project was made possible by Northern Ontario Heritage Fund Corporation (NOHFC) and The Industrial Research Assistance Program (IRAP). Other funding sources were: Thunder Bay Ventures, Rainy River Future Development Corporation, Patricia Area Community Endeavors, Sudbury Regional Development Corporation, LaCloche Manitoulin Business Assistance Corporation, Dryden Federation of Agriculture and Soil and Crop Improvement Associations from Thunder Bay, Rainy River, Dryden, Sudbury and Manitoulin Island. In-kind contributions were made from: Kenex Ltd., Thunder Bay Co-op Farm Supply, Emo Feed Service, Lakehead University department of Forestry, 28 farmer cooperators and Kemptville College/University of Guelph. The Quetico Centre, Atikokan, Ontario was the contract administrative sponsor for the project and contributed it's services as in-kind contribution.

Research Facilitators

Gordon Scheifele, M.Sc., Research Coordinator for Northern Ontario, Kemptville College/University of Guelph, Thunder Bay, Ontario, Canada was project manager assisted by: Herb Hinz (summer student as field research assistant, Lakehead University Forestry Department 4 th year student); Karen Davies, Kim-Jo Bliss Calder, Matt Bowman as research technical staff; Laurier Guillemette, Research Station Manager. Twenty eight farmer cooperators were significant research facilitators in the on-farm strip trial research/demonstration component.

| Top of Page |

Project Outline

The hemp varieties Secuieni 1, Irene, Fedora 19, Felina 34, Fedrina 74, Unico B and Kompolti were planted at 32 sites (2 hectares strip trials at each site) across northern Ontario for fibre and grain production studies: (Manitoulin Is. (2), Sudbury (3), Verner (3), Thunder Bay (7), Dryden (5), Rainy River (10), Kapuskasing (1) and New Liskeard (1)). Tissue samples were harvested from 30 randomly selected tops of plants (top 1/3 or less of the plant) in the fibre production strips 50 days post emergence for Secuieni 1 and Irene and at 50% pollen shedding (75-80 days post planting) for all varieties (following the protocol as required by Health Canada). Harvested tissue samples were air and oven dried at 40 degree C and then ground in preparation for laboratory chemical analysis to determine the THC content. The THC contents are reported in a quantified (%) measurement for the two stages of development for 30 environments. Meatherall Consulting, Winnipeg, Manitoba was the Health Canada certified and licensed laboratory contracted to do the chemical analysis for THC content determination.

Results of THC analysis were obtained from southern (Dragla) and eastern Ontario (Madill) and were summarized with those from northern Ontario to characterize variety genetic stability and environmental, latitude and altitude response.

The varieties, Secuieni 1, Irene, Unico-B, Kompolti and Kompolti Hybrid TC were planted in the following 5 latitudes and sites in Ontario: 42 ° 25' (Chatham at 183 m altitude), 47 ° 30' (New Liskeard at 194 m altitude), 48 ° 30' (Thunder Bay at 213 m altitude), 48 ° 45' (Emo at 366 m altitude) and 49 ° 30' (Kapuskasing at 218 m altitude). Tissue samples were harvested at 50% pollen shedding, dried and ground for laboratory analysis for THC content following the same protocol as above.

Licences

A total of 32 research licences for possession, production, sending, transportation and delivery for Controlled Drugs and Substances (*Cannabis sativa*) were issued from health Canada to Gordon Scheifele, University of Guelph. The 32 licences and respective site description are summarized in **Table 1.** The required GPS coordinates for each site were obtained after planting and were submitted to Health Canada as required.

| Top of Page |

Results and Discussion

Weather. *Kapuskasing:* Very dry in early spring during planting season and below normal precipitation with periods of drought conditions for the remainder of the growing season. Above normal temperatures and a record lengthy growing season. *Dryden:* adequate moisture in the spring during planting with below normal precipitation causing periods of drought conditions during the growing season. Above normal temperatures with a historically lengthy growing season from early spring to fall. *Rainy River:* Very dry in early spring during planting season with 7-8 cm precipitation within 30 hours in mid June contributing to saturated soils and flooding. Below normal precipitation for the growing season with periods of drought conditions, above normal temperatures and a record lengthy growing season. *Thunder Bay:* The entire growing season from early spring to early fall would be best characterized as very drought conditions with above normal temperatures and a record lengthy growing season. *New Liskeard, Verner, Sudbury and Manitoulin Is.:* Very dry spring planting conditions with 7-8 cm of precipitation within 24 hours May 30 th . The remainder of the growing season remained below normal precipitation with periods of drought conditions. Above normal temperatures and record lengthy growing season. *Chatham/Leamington:* Below normal precipitation causing periods of drought conditions and above normal temperatures with a record lengthy growing season. *Eastern Ontario and Southwestern Quebec:* Adequate precipitation with above normal temperatures and a record lengthy growing season.

Summary of Status of Hemp On-Farm Strip Research/Demonstration Trials.

Table 2 describes of each site with respective Health Canada Licence numbers, soil type, comments and

harvest information. The last two digits of the licence number will be used as site reference numbers throughout the remaining manuscript.

Secuieni 1 and Irene 50 days post emergence. The results of THC analysis at 50 days post emergence for Secuieni 1 and Irene are summarized in **Table 3** by variety, region and 30 sites for northern and northwestern Ontario. Secuieni 1 and Irene gave a range of values from 0.05 to 0.33 and 0.05 to 0.40% THC respectively and overall means of 0.16 and 0.15% THC respectively over 30 sites. Thunder Bay (48 ° 30' latitude and altitude of 213 m) and Sudbury (46 ° 30' latitude and 290 m altitude) regions gave the overall lowest (0.07%) and highest (0.23%) values respectively. Sudbury, Manitoulin Is. and Verner were regions with lower latitude and altitude but highest THC values (0.233, 0.195 and 0.188 respectively), which is opposite to that expected. All three sites in Sudbury were consistently high (>0.2% THC) for both varieties. The soil types varied from sandy loam (site 22), sandy (site 23) and clay loam (site 24). Fertility was excellent at all three sites but drought was sustained during the growing stage. Dryden had the highest latitude (49 ° 45') and altitude (413 m) and ranked the 2 nd highest (0.225%) for THC levels, again contrary to that expected. Three of the 5 Dryden sites (sites 19, 20 & 21) averaged 0.24% THC and higher and Secuieni 1 and Irene exceeded the 0.3% THC levels at sites 19 and 20. Sites 19 and 20 were both quite drought stressed and on heavier clay soil with plant heights ranging 1 meter and less. However, site 21 (clay soil) had plant heights ranging from 2-3 meters and had good fertility with some drought stress and average THC levels of 0.365%. It is unclear at this time what contributed to the high THC levels at site 21. Manitoulin Is. (195-200 m altitude) and Verner (202 m altitude) regions also had heavier clay soils combined with drought stress and Secuieni 1 had relatively high (>0.19%) THC levels at all of these 5 sites (sites 25, 26, 27, 28, and 31). The Rainy River region (sites 9-16 & 32) had relatively low THC levels. All of these sites had heavier clay soil except site 15, which was a sandy loam soil type. Secuieni 1 did produce relatively high THC levels (>0.18%) at sites 9 (0.21%), 14 (0.19%), 16 (0.19%) and 32 (0.18%). Each of these sites did sustain significant water stress within 2 weeks of planting due to 7-8 cm of precipitation within 36 hours. Sites 11,12 & 13 sustained the same water stress but did not reflect the response in high THC levels. The environmental factors contributing to stress in hemp resulting in higher THC levels is still not apparent from these data. **Graph 1** presents the summary of the data in a regression of individual site values against the % THC environment mean (site mean of varieties) for both varieties. The overall environment mean was 0.15% THC. Secuieni 1 and Irene gave a relatively high R^2 of 76 and 80.4% respectively demonstrating a relatively strong genetic stability (higher R^2 values reflect stronger genetic stability). The slopes of both regression lines were 0.936 and 1.064 for Secuieni 1 and Irene respectively demonstrating a similarity in a strong response to the environment (slope represents response to the environment; the steeper slope is interpreted to reflect stronger response). The standard deviation values for the environment, Secuieni 1 and Irene were 0.077, 0.083 and 0.092 respectively. The range of actual environment means was 0.07 to 0.233% THC. The preliminary statistical analysis of these data demonstrated a highly significant genotype x environment interaction. The strong response of both varieties to the environment (average slope of 1) demonstrated their potential tendency to exceed the 0.3% THC legal limit given appropriate environmental contributing conditions.

50% Pollen Shedding (75-80 days post planting). The results of THC analysis for samples harvested at 50% mid flowering (75-80 days post planting) for all 7 varieties grown in northern and northwestern Ontario are summarized by variety, region and 30 sites in **Table 4** . Sites 3 and 19 are represented twice due to separate sampling of uniquely different areas within each field. Site 19 (Jackson-2) was spring plowed just prior to planting, had significantly shorter plants (75 cm) and was more drought stressed than the Jackson-1 section (1-1.5 m in plant height). The THC levels in the Jackson-2 section of the field were considerably higher than the less stressed portion of the field (Jackson-1). The two different areas of site 3 gave very similar THC results (TBARS site was planted later and fertilized separately). The varieties and regions are ranked from lowest to highest %THC levels. Unico B exceeded the 0.3% THC level at one site in Rainy River, Secuieni 1 exceeded the 0.3% THC level 1, 2, 1, 2 and 2 times in Dryden, Thunder Bay, New Liskeard, Sudbury and Rainy River respectively (total of 8 times) and Irene exceeded the 0.3% THC level 1, 1 and 2 times at Dryden, Sudbury and Rainy River respectively (total of 4 times). The lowest site mean was 0.07% THC at Kapuskasing (49 ° 30' latitude and 218 m altitude), Verner (46 ° 30' latitude and 202 m altitude)and Dryden (49 ° 45' latitude and 413 m altitude) and the highest site mean was 0.24% THC in Rainy River (48 ° 45" latitude and 366 m altitude). Felina 34 (range of 0.03-0.16%) and Fedrina 74 (range of 0.05-0.30%) had the overall lowest means at 0.08% THC. Fedrina 74 reached a 0.3% THC level in site 14 which was the highest of all 7 varieties at this site (site mean = 0.24%). Secuieni 1 had the highest overall mean level of THC at 0.23% with Irene 2 nd highest at 0.16%. Secuieni 1 significantly increased it's THC levels from 50 days post emergence (0.16%) to 50% pollen shedding (0.23%), whereas, Irene gave little change (0.15% at 50 days post emergence to 0.16% at 50% pollen shedding). The correlation for THC levels

between 50 days post emergence and 50% flowering was 25% for Secuieni 1 and 15% for Irene. These low correlations reflect a very poor relationship for THC accumulation in the plant between 50 days post emergence and 50% flowering (two stages of maturity). **Graph 2** summarizes these data in the regression of the variety site THC levels over the % THC Environmental Means (individual site means). Felina 34, Kompolti and Fedora 19 produced the lowest slopes (0.442, 0.563 and 0.569 respectively) and R^2 values (35.3, 30.2 and 35.2% respectively), demonstrating the lowest response to the environment and least genetic stability. It is not expected that these varieties would exceed the 0.3% THC levels even under extreme stressed conditions. Even though Fedora 19 had a higher mean value (0.109%) it's low slope (0.57) would suggest it to be quite safe. Fedrina 74 demonstrated a slightly steeper slope (0.738), responding more with the environment and a considerably higher R^2 (52.6%), showing more genetic stability. Fedrina 74 (mean =0.084%) did reach a 0.3% THC level once in the 30 environments at site 14 and has the genetic freedom to exceed 0.3% THC level under extreme stress conditions. Secuieni 1 had the steepest slope of 1.9 and a R^2 value of 60.5% demonstrating a strong response to the environment with more genetic stability than Felina 34, Kompolti and Fedora 19. Irene demonstrated the greatest genetic stability (R^2 of 68.1%) with a steep slope of 1.6 which was a slightly less environmental response than Secuieni 1. Unico B (R^2 of 63.1%) had more genetic stability than Secuieni 1 (R^2 of 60.5%) but responded less with the environment (slope of 1.095 compared to 1.9 for Secuieni 1). Unico B demonstrated its ability to exceed the 0.3% THC level on several occasions but is less likely to do so because of its lower response to the environment (slope 1.095) and greater genetic stability.

All Ontario THC Summary.

Table 5 summarizes the THC data collected at 50% to final pollen shed for southern Ontario and southwestern Quebec. The data in **Table 5** identifies the number of sites in a mean (N), the mean, low and high value, the standard deviation for more than two sites in a mean (Sd) and the number of times it exceeded 0.3% level (>0.3%). Fedora 19 exceeded the 0.3% level (0.34%) once in 8 sites. Secuieni 1 and Irene exceeded the 0.3% level 8 in 21 sites and 1 in 1 site respectively. Irene exceeded the 0.3% level at the St. Joachim site. These data and those from northern and northwestern Ontario industrial hemp sites are combined and summarized in **Table 6** , ranking the 7 varieties and 14 regions from lowest to highest %THC levels. The ranking of the %THC means of the 14 regions does suggest a trend in latitude effect on %THC levels. The two regions which don't fit into this pattern are Rainy River (ranking 3 rd highest for %THC and the 3 rd highest latitude) and Leamington (the 3 rd lowest %THC and the lowest latitude). The varieties with the lowest %THC levels are Felina 34, Fedrina 74 and Kompolti. Fedora 19 is slightly higher than the former 3 varieties but it's range of values is similar to that of the former 3 varieties. Secuieni 1 and Irene have the highest levels of %THC. Secuieni 1 had an overall mean %THC level in the Chatham region of 0.32% over 21 sites. **Graphs 3 to 9** summarize the data of mean %THC levels for the 7 varieties across the regions in Ontario and southwestern Quebec. Each graph summarizes the mean, number of sites represented and the low-high values represented in the mean. The region means are ranked from lowest to highest in each graph for the respective variety . **Graph 3, Felina 34** : Chatham the lowest latitude has the 4 th lowest %THC region mean (0.08) and Sudbury and Rainy River (one of the higher latitude sites) have the highest %THC region mean. **Graph 4, Fedrina 74** : Rainy River has the second highest region mean when it should be one of the lowest. A trend for lower %THC levels with higher latitudes does exist. **Graph 5, Kompolti** : Chatham is the 4 th lowest %THC region mean and Rainy River is the second highest. **Graph 6, Fedora 19** : The trend for lower %THC levels at higher latitudes exists with the exception of Leamington. **Graph 7, Unico B** : Rainy River has the 2 nd highest %THC region mean and Chatham and Leamington have the 5 th and 6 th lowest. The trend for Unico B is weak. **Graph 8, Irene** : The exception of Leamington (the 3 rd lowest) and Rainy River (the 3 rd highest), there is a trend. **Graph 9, Secuieni 1** : There appears to be no real trend in these data other than Chatham with 21 sites in its mean is the 2 nd highest. A review of these data by individual variety considering latitude demonstrates a trend for lower THC levels at higher latitude with exceptions. Some varieties appear to demonstrate this tendency better than others addressing the fact that genetics of the variety is still a main component controlling the variety's THC production and reaction to the environment.

Kompolti Hybrid TC Response to Latitude. These data are summarized in **Graph 10** . The %THC data for the hemp variety Kompolti Hybrid TC strongly suggests a response to reduced %THC levels as latitude is increased. Bocsa had identified this variety to be especially responsive to latitude effect in eastern Europe. The exception to the trend is New Liskeard (NLARS) which had the lowest %THC (0.06) for Kompolti Hybrid TC. Kompolti and Secuieni 1 demonstrated lower %THC levels with higher latitudes. Irene followed the same pattern with the exception of the Thunder Bay location. At this time it is unknown how significant the relatively

small incremental differences of 1 to 2 degree in latitude can have on the production of THC in hemp varieties. It must also be mentioned that elevation is a variable component potentially effecting these data (Bocsa). The 5 locations in mention have the following altitudes: Kapuskasing 218 m, Emo 366 m, Thunder Bay 213 m, New Liskeard 194 m and Chatham 183 m above sea level. Kapuskasing, Thunder Bay, New Liskeard and Chatham are all considered quite similar in altitude with Emo considered to have a significantly higher altitude. Thunder Bay is the only location situated within the influence of a large cold water mass (Lake Superior) significantly modifying its environment. Emo in the Rainy River district is modified predominantly in precipitation quantity and distribution during growing seasons due to the water effect of Lake of the Woods and Rainy Lake.

| Top of Page |

Conclusions

Secuieni 1 and Irene. The regression analysis summarized in **Graph 1 and 2** characterizes the behavior of these two varieties for THC levels across northern Ontario in 1998. It is apparent from both stages of sampling that both varieties have a relatively strong genetic stability (demonstrated by high R^2 values) and respond very strongly to the environment (demonstrated by the steep slope values of greater than 1). The 1996 to 1998 production seasons demonstrated that these varieties had the genetic freedom to develop THC levels in excess of 0.3% quite readily given appropriate environmental conditions. The strongest indicators addressing this tendency are the steep regression slopes. In the Chatham region (**Table 5)** Secuieni 1 and Irene exceeded the 0.3% THC limit 8/21and 1/1 times respectively. The summaries in **Table 4** show Secuieni 1 and Irene exceeding the 0.3% THC limits 8/30 and 4/30 times respectively. The data showed no correlation between the earlier and later sampling and sites which demonstrated higher THC levels in excess of 0.3% in the earlier sampling (**Table 3** , sites 19 and 21) were less than 0.3% in the later sampling (**Table 4**). Rainy River region was the 3 rd lowest (0.119) region in the early sampling and was the highest (0.17) in the later sampling. Site 20 was the only one in which Secuieni 1 exceeded the 0.3% level at both times of sampling. The later sampling period (50% pollen shed) would appear to be the most reliable and adequate and the only one necessary. The two stages of THC sampling (50 days post emergence and 50% pollen shed) are considered to have been unnecessary. Considering the established legal limit of 0.3% THC, the strong response of Secuieni 1 and Irene to the environment and in spite of their outstanding performances for stalk and grain yield, these two monoecious varieties should be considered unsafe for Ontario and Canadian production.

Summary of THC Performance for 7 Low THC Hemp Varieties Grown In Ontario In 1998.

These data are summarized in **Tables 4, 5 and 6** and **Graphs 2 to 9** . The regression analysis summarized in **Graph 2** characterizes each of the 7 varieties. The least genetically stable varieties (Felina 34, Fedora 19 and Kompolti) are also the ones which respond the weakest with the environment and hence the safest varieties not to exceed the THC legal limits. Fedrina 74 is also considered quite safe with more genetic stability. This variety did reach the 0.3% legal limit in site 14 (Rainy River) and in Chatham but did not exceed the legal limit. Unico B with a slope of 1.095 can be expected to exceed the legal limit on rare occasions, but in spite of it's steep slope, it's stronger genetic stability will limit it to do so only rarely. It did exceed the legal limit 1/28 times (site 16) in northern Ontario. Secuieni 1 and Irene both have very steep slopes (1.9 and 1.6 respectively) and in spite of their stronger genetic stability (R^2 = 60.5 and 68.1 respectively) can be expected to exceed the legal limits quite frequently. Preliminary statistical analysis demonstrated a strong highly significant genotype x environment interaction as reflected by the low range of R^2 values (30.2 to 68.1).

Higher Latitude Effect. The greatest acreage potential for industrial hemp production in Canada will be north of the 46 th latitude. The hemp production acreage in southern and eastern Ontario and southeastern Quebec will be between the 42 nd and 46 th latitude. **Table 6** and **Graph 10** give a good overall summary and identify a trend for latitude effect on THC levels. **Graphs 3** to **9** summarize the THC data by variety over the production regions. Both the summarized data in **Graph 10** and **Table 6** show the tendency for lower THC levels at higher latitudes. The low THC levels from Leamington for 6 varieties is the exception and unexplainable. The high THC levels for Rainy River region (48 ^{0} 45')are also unexplainable (in ranking order of THC level, it falls between the latitudes of 45 ^{0} and 45 ^{0} 30'). It is further unknown the minimum degrees latitude required to begin to impact THC levels in hemp varieties. It also appears that varieties will respond

differently to the increase in latitude. The behavior of Secuieni 1 and Irene certainly demonstrates that varieties with a strong response to the environment will produce higher levels of THC regardless of latitude. Many other uncontrolled environmental variables complicate this effect including altitude. Dryden (413 m) and Rainy River (366m) were the two highest elevations in the 1998 Ontario study. All the other regions were less than 290 m (Chelmsford) above sea level.

THC sampling in the future should be restricted to the stage of plant maturity defined as 50% flowering and pre seed maturation. Secuieni 1 and Irene demonstrated their abilities to exceed the 0.3% legal limits quite freely and should be considered unsafe for future Ontario and Canadian production in compliance with Health Canada regulations. Higher latitudes can reduce THC levels in hemp plants with varieties responding differently. The agronomic research initiatives in Canada will be challenged to more completely understand the stress components which cause the hemp plant to produce higher levels of THC content. These unknown factors will continue to frustrate and complicate Canadian efforts to develop new varieties to remain consistently below the legal limit of 0.3% THC content and perform competitively for fibre and grain production. Based on the above information THC screening efforts in more southern latitudes such as southern Ontario would be expected to apply the greatest screening pressure on selection of genetic materials for consistent low percent THC levels. Such screened materials could then be further selected in the respective anticipated production regions for performance and local adaptation.

| Top of Page |

Acknowledgments

John Madill, Kemptville College/University of Guelph, Kemptville, Ontario and Peter Dragla, Ridgetown College/University of Guelph, Ridgetown, Ontario for supplying southwestern Quebec and southern Ontario THC data. Gary Hoekstra, Kemptville College/University of Guelph, Kemptville, Ontario for doing the preliminary ANOVA statistical analysis.

References

Bocsa, Ivan. 1998. The Cultivation of Hemp. Hemptech. Pg. 59-61.

Dragla, Peter. 1997. 1997 Industrial Hemp Research Report. Ridgetown College, Ridgetown, Ontario Canada.

Scheifele, Gordon. 1996. Hemp (*Cannabis sativa*) Research Report for Kent County, Ontario, Canada. Ridgetown College, Ridgetown, Ontario, Canada.

Scheifele, Gordon. 1997. Exploring the Feasibility of Growing Industrial Low THC Hemp in Northwestern Ontario. Kemptville/University of Guelph, Thunder Bay, Ontario, Canada.

| Top of Page |

TABLE 1

Summary of '98 NOHFC Hemp Research/Demonstration Project Five Acre On-Farm Strip and Replicated Research Trial Sites

				Plot Location		
Five Acre On-Farm Strip Trial Cooperators	**Licence Number**	**Address**	**District**	**Lot**	**Conc.**	**County**
*Steve Aho	98-S0001-R-01	RR #1, South Gillies, ON P0T 2V0	Thunder Bay	S1/2 9	3	Scoble
Donald Henry Belluz	98-S0001-R-02	RR #6, Thunder Bay, ON P7C 5N5	Thunder Bay	20	2	Oliver/Paipoonge

Arnold J. Breukelman	98-S0001-R-03	RR #6, Thunder Bay, ON P7C 5N5	Thunder Bay	8	2	Oliver/Paipoonge
Gerrit J. Brink, Sandy Acres Farms Inc.	98-S0001-R-04	RR #5, Thunder Bay, ON P7C 5M9	Thunder Bay	28	1	Oliver/Paipoonge
William Charles F. Farmer	98-S0001-R-05	125 Mud Lake Road, Murillo, ON P0T 2G0	Thunder Bay	8	1	Oliver/Paipoonge
John Hanna	98-S0001-R-06	Box 244, Vickers Heights, ON P0T 2Z0	Thunder Bay	13	2 SR	Oliver/Paipoonge
Emil Meier	98-S0001-R-07	299 Ouimet Canyon Road, RR #1, Dorion, ON P0T 1K0	Thunder Bay	4	6	Thunder Bay
Donelda A. DelaRonde	98-S0001-R-08	406 Victoria Avenue East, Thunder Bay, ON P7C 1A5	Rainy River	S1/2 10	2	Potts
Kenneth Fisher	98-S0001-R-09	Box 66, Emo, ON P0W 1E0	Rainy River	SW1/4	Sec 10	Lash
Dianne Herod	98-S0001-R-10	Box 13, Pinewood, ON P0W 1K0	Rainy River	S1/2 NE1/4	Sec 5	Nelles
Brent Hyatt	98-S0001-R-11	P. O. Box 261, Emo, ON P0W 1E0	Rainy River	10	1	Carpenter
Larry W. Lamb/Purity Seeds Limited	98-S0001-R-12	Box 555, Emo ON P0W 1E0	Rainy River	21	River Range	Lash
Grant Lougheed	98-S0001-R-13	Box 478, Emo ON P0W 1E0	Rainy River	4	River Range	Lash
Blair J. Lowey	98-S0001-R-15	RR #1, RMB #7, Fort Frances, ON P9A 3M2	Rainy River	4	River Range	Alberton
Dean Peters	98-S0001-R-14	RR #1, Sleeman, ON P0W 1M0	Rainy River	NW1/4 9	Dawson Blue	Rainy River
Jack Vandenbrand	98-S0001-R-16	RR #1, Stratton, ON P0W 1N0	Rainy River	SW 1/4	Sec 32	Morley
Peter W. Brunner	98-S0001-R-17	Box 7, Dinorwic, ON P0V 1P0	Kenora	10	5	Southworth
Harold Ingebrigtsen	98-S0001-R-18	Site 216, Box 2, RR #2, Dryden, ON P8N 2Y5	Kenora	S1/2 Lot 6	1	Rugby
Lee Jackson	98-S0001-R-19	RR #2, Site 216, Box 35, Dryden, ON	Kenora	S1/2 Lot 6	5	Eton

		P8N 2Y5				
Gerald MacRae	98-S0001-R-20	Box 3, Site 216, RR #2, Dryden, ON P8N 2Y5	Kenora	9	6	Eton
Eric Parker	98-S0001-R-21	Box 51, Oxdrift, ON P0V 2J0	Kenora	10 N1/2	2	Eton
Steven Mailloux	98-S0001-R-22	100 Mailloux Road, Walford, ON P0P 2E0	Sudbury	N1/2	Sec 29	Victoria
Claude L. Rainville	98-S0001-R-23	3268 St. Laurent Street, Chelmsford, ON P0M 1L0	Sudbury	1	5	Bayside
Mike Soenens	98-S0001-R-24	333 Bonin Street, Chelmsford, ON P0M 1L0	Sudbury	10	5	Sudbury
Mike Lecuyer	98-S0001-R-25	P. O. Box 625, Little Current, ON P0P 1K0	Manitoulin	7 and 8	9	Howland
Lyle Noland	98-S0001-R-26	RR #1, Spring Bay, ON P0P 2B0	Manitoulin	7	10	Campbell
*Rhial H. Brouillitte	98-S0001-R-27	740 Rainville Road, Verner, ON P0H 2M0	Verner	6	B	Nipissing
*Daniel Olivier	98-S0001-R-28	RR #1, Verner, ON P0H 2M0	Verner	8	3	Caldwell
Replicated Research Sites						
Laurier Guillemette, Agriculture and Agri-Food Canada	98-S0001-R-29	Research Farm, P. O. Box 160, Kapuskasing, ON P5N 2Y3	Cochrane	24	13	O'Brien
John Rowsell, New Liskeard Agricultural Research Station	98-S0001-R-30	Box 4020, 340 Armstrong Street, New Liskeard, ON P0J 1P0	Temiskaming	9	2	Dymond
John Rowsell, New Liskeard Agricultural Research Station	98-S0001-R-31	Box 4020, 340 Armstrong Street, New Liskeard, ON P0J 1P0	Nipissing	7	4	Caldwell

Kim Jo Bliss Calder, Emo Agricultural Research Station	98-S0001-R-32	Hwy 11, 1.5 km West of Emo, Emo, ON P0W 1E0	Rainy River	N part Lot 4 & 5	Barwick River Range	Chapple
Karen Davies, Thunder Bay Agricultural Research Station	98-S0001-R-03	335 Euclid Avenue, Thunder Bay, ON P7E 6G6	Thunder Bay	8	2	Oliver/Paipoonge
*not part of NOHFC project						

TABLE 2

SUMMARY OF STATUS OF HEMP ON-FARM STRIP RESEARCH/DEMONSTRATION TRIALS

Site Cooperator	Condition	Height	Harvest Intentions	Soil Type	Comments	Bales Stalks	Tonnes Stalks	Grain Combined
Thunder Bay								
Steve Aho* South Gillies** 98-S0001-R-01***	very poor	1'-3'	not harvested	sandy clay loam	freshly cleared land in spring, 1998; poor fertility; planted too late - end of June; too dry; destroyed in August.	0	0	No
Don Belluz Thunder Bay 98-S0001-R-02	good to very good	5'-10'	harvested for fibre and grain	sandy loam	some drought stress, stalk breakage and grasshopper damage. hemp field day host site.	16 (4'x6')	8	Yes
Arnold Breukelman Thunder Bay 98-S0001-R-03	good	4'-5'	harvested for fibre and grain	sand	very uniform but short; drought stressed.	8 (4'x6')	4	Yes
					excellent start from emergence to 3';			

Gerry Brink Thunder Bay 98-S0001-R-04	good to poor	6'-8'	harvested fibre only from 1/3 of field	sandy loam	extensive stalk breakage (60-80%) due to excessive N and drought stress; destroyed 2/3 of field.	14 (4'x5')	4.9	No
Bill Farmer** Murillo 98-S0001-R-05	good to very good	5'-10'	harvested for fibre only	clay loam to sandy loam	variability due to variability in soil and fertility; destroyed grain strip; fibre not baled; field pasture for over 10 years; unable to get baled.	0	0	No, only by hand
John Hanna Thunder Bay 98-S0001-R-06	good to very good	6'-10'	harvested for fibre and grain	sandy loam	some spots poor stand due to rough seed bed conditions.	17 (4'x5')	5.1	Yes
Emil Meier** Dorion 98-S0001-R-07	good	3'-9'	harvested for fibre	clay loam	quite variable due to soil variability and drought stress; hay field for over 18 years; destroyed grain strip; unable to get combined.	13 (4'x6')	7.7	No
					Total Tonnes Stalks		**29.7**	
Rainy River								
Donelda Delaronde Emo 98-S0001-R-08	very poor	0	not harvested	clay	field destroyed in July; poor emergence and drowned due to heavy June rain and poor drainage.	0	0	No
Ken Fisher Emo 98-S0001-R-09	poor	4'-6'	harvested best areas for fibre only	clay loam	poor due to heavy June rain and inadequate drainage and lack of	7 (4'x6')	3.5	No

					fertility.			
Wayne Herod Pinewood 98-S0001-R-10	good to fair	4'-6'	harvested for grain and fibre	clay loam	lack of fertility affecting height; some drought stress; organic production.	19.5 (4'x5')	5.7	Yes
Brent Hyatt** Emo 98-S0001-R-11	very poor	1'-3'	no harvest	clay	lack of fertility and poor drainage - heavy June rain; destroyed before harvest; idle pasture land for past 15 years.	0	0	No
Larry Lamb Emo 98-S0001-R-12	poor to good	3'-9'	harvested best areas for fibre only	clay	due to heavy June rain, too wet and inadequate drainage for heavy soil; good over tile drains.	10 (4'x6')	6.5	No
Grant Lougheed Emo 98-S0001-R-13	poor	2'-3'	no harvest	clay	heavy soil and inadequate fertility and drainage - heavy June rain; destroyed before fibre harvest.	0	0	No
Blair Lowey Fort Frances 98-S0001-R-15	good to very good	7'-10'	harvested for fibre and grain	sandy loam	spots drowned due to excess moisture in June and some spots poor emergence. hemp field day host site.	19.5 (4'x6')	9	Yes
Dean Peters Sleeman 98-S0001-R-14	very good	6'-10'	harvested for fibre and grain	clay loam	some spots poor due to heavy rain and inadequate drainage.	17 (4'x6')	10.2	Yes
					some spots poor due to			

Jack Vandebrand Stratton 98-S0001-R-16	very good	6'-10'	harvested for fibre	clay loam	heavy rain and inadequate drainage; destroyed grain portion; unable to get combined.	18.5 (4'x6')	10.9	No
					Total Tonnes Stalks		**45.8**	
Kenora/Dryden								

Table 2 Continued

Peter Brunner Dinorwic 98-S0001-R-17	very good	7'-10'	harvested for fibre and grain	clay loam	only few small areas poor due to poor drainage; very uniform.	40 (4'x5')	12.7	by hand only
Harold Ingebritsen Dryden 98-S0001-R-18	good	5'-6'	harvested for fibre and grain	clay loam	very uniform; acid pH and lack fertility; drought stressed.	12 (4'x6')	7	Yes
Lee Jackson Dryden 98-S0001-R-19	poor to good	4'-5'	harvested for grain only	clay	spring plowed; drought stress; very short but uniform.	0	0	Yes
Gerald MacRae** Dryden 98-S0001-R-20	very poor	1'-7'	harvested good areas only for fibre	clay	very uneven and poor due to poor soil conditions and inadequate fertility; field pasture for over 10 years; acid pH and lack organic matter.	50 (square bales)	0.7	No
Eric Parker Oxdrift 98-S0001-R-21	very good	7'-9'	harvested for fibre and grain	clay	very uniform and good growth. hemp field day host site.	43 (4'x5')	15	Yes
					Total Tonnes Stalks		**35.4**	
Sudbury								
					very uniform and good			

Steve Mailloux Walford 98-S0001-R-22	very good	7'-10'	harvested for fibre and grain	sandy loam	growth; some stalk breakage. hemp field day host site.	32 (4'x5')	11.2	Yes
Claude Rainville Chelmsford 98-S0001-R-23	very poor	2'-10'	harvested small good area for grain (<0.5 ac)	sandy	no emergence due to planting too deep in very dry, over-worked seed bed followed by heavy rain; destroyed 4.5 ac end of July.	0	0	Yes
Mike Soenens Chelmsford 98-S0001-R-24	good to very good	6'-10'	harvested for fibre and grain	clay loam	some poor areas due to poor drainage and soil variability.	23 (4'x5')	8	Yes
					Total Tonnes Stalks		**19.2**	
Manitoulin								
Mike Lecuyer Little Current 98-S0001-R-25	good to poor	4'-10'	harvested for fibre only	clay loam	poor drainage in areas and soil conditions; inadequate fertility; grain portion destroyed; fibre portion not baled.	0	0	No
Lyle Noland Spring Bay 98-S0001-R-26	poor to good	4'-10'	harvest for fibre only	clay	poor emergence due to planting too deep and seed bed too dry; soil variability; destroyed grain strip; unable to get combined.	20 (4'x5')	7	No
					Total Tonnes Stalks		**7.0**	
Verner								

Rhial Brouillette* Verner 98-S0001-R-27	poor to very good	3'-10'	harvest for fibre only	clay	poor drainage causing poor growth in areas, good areas very good.	28 (4'x5')	10	No
Daniel Olivier* Verner 98-S0001-R-28	good	5'-9'	harvest for fibre only	clay	some poor areas otherwise quite uniform and good; drought stressed; grain strip destroyed; unable to get combined.	14 (4'x5')	5	No
					Total Tonnes Stalks		**15.0**	
				GRAND TOTAL TONNES OF STALKS			**152.1**	

* not NOHFC project participants
** idle land not previously cropped
*** HC licence number

Table 3

Summary of % THC values for northern and northwestern Ontario 1998 industrial hemp trials for Secuieni 1 and Irene 50 days post emergence (3rd to 4th week of July). Values are summarized by variety, region and 30 sites.

Region	Latitude	Secuieni 1	Irene	Mean	Site	Cooperator
Thunder Bay	48 ^{o} 30'	0.07	0.05	0.06	2	Belluz
		0.24	0.05	0.145	3	Breukelman
		0.05	0.05	0.05	4	Brink
		0.05	0.05	0.05	5	Farmer
		0.05	0.05	0.05	6	Hanna
		0.07	0.06	0.065	7	Meier
Mean		0.0883	0.0517	0.070(1)		
Rainy River	48 ^{o} 45'	0.21	0.08	0.145	9	Fisher
		0.12	0.11	0.115	10	Herod
		0.13	0.08	0.105	11	Hyatt
		0.09	0.06	0.075	12	Lamb
		0.09	0.06	0.075	13	Lougheed

		0.05	0.16	0.105	15	Lowey
		0.19	0.10	0.145	14	Peters
		0.19	0.19	0.19	16	Vandebrand
		0.18	0.18	0.18	32	EARS
Mean		0.1563	0.1275	0.119(3)		
Dryden	49 º 45'	0.12	0.07	0.095	17	Brunner
		0.12	0.16	0.14	18	Ingebrigsten
		0.11	0.37*	0.24	19	Jackson
		0.32*	0.25	0.285	20	MacRae
		0.33*	0.40*	0.365	21	Parker
Mean		0.20	0.25	0.225(7)		
Sudbury	46 º 30'	0.26	0.22	0.24	22	Mailloux
		0.25	0.18	0.215	23	Rainville
		0.23	0.26	0.245	24	Soenens
Mean		0.2467	0.22	0.233(8)		
Manitoulin	45 º 50'	0.21	0.18	0.195	25	Lecuyer
		0.19	0.20	0.195	26	Noland
Mean		0.20	0.19	0.1950(6)		
Verner	46 º 30'	0.25	0.15	0.20	27	Brouillitte
		0.26	0.14	0.20	28	Olivier
		0.22	0.11	0.165	31	VARS
Mean		0.243	0.133	0.1883(5)		
Kapuskasing	49 º 30'	0.19	0.10	0.145(4)	29	KARS
New Liskeard	47 º 30'	0.10	0.09	0.095(2)	30	NLARS

*Values exceeding 0.3% THC level

( ) Ranked from lowest to highest % THC levels

Overall mean for Secuieni 1 = 0.16 and Irene = 0.15 for above 30 sites.

Table 4

Summary of % THC values for industrial hemp varieties grown in northern and northwestern Ontario in 1998 over 30 sites in eight regions. Varieties and regions are ranked from lowest to highest for % THC values

Samples for THC analysis were harvested at 50% of pollen shed 80-90 days post seeding

				Varieties							
Region	Latitude	Site	Cooperator	Fedrina 34	Fedrina 74	Kompolti	Fedora 19	Uniko-B	Irene	Secuieni 1	Site Mean
Kapuskasing (1)	49° 30'	30	KARS	0.07	0.09	0.06	0.12	0.08	0.06	0.06	0.07
Verner (3)	46° 30'	27	Brouillitte	0.05	0.10	0.05	0.12	0.09	0.08	0.10	0.08
		28	Olivier	0.05	0.05	0.07	0.09	0.07	0.10	0.18	0.07
		31	VARS	0.03	0.08	0.06	0.05	0.07	0.05	0.21	0.08
Region Mean				0.04	0.08	0.06	0.09	0.08	0.08	0.16	0.07
Dryden (6)	49° 45'	17	Brunner	0.05	0.05	0.05	0.08	0.07	0.09	0.23	0.08
		18	Ingebrigsten	0.05	0.06	0.07	0.05	0.05	0.07	0.09	0.06
		19	Jackson-1	0.07	0.07	0.05	0.07		0.05	0.11	0.07
		19	Jackson-2	0.14	0.09	0.06	0.12	0.05	0.2	0.28	0.13
		20	McRae	0.16	0.16	0.13	0.20	0.14	0.34*	0.53*	0.23
		21	Parker	0.06	0.06	0.08	0.16	0.08	0.19	0.16	0.11
Region Mean				0.06	0.06	0.07	0.11	0.08	0.16	0.22	0.10
Manitoulin (2)	45° 50'	25	Lecuyer	0.07	0.05	0.12	0.05	0 10	0.14	0.27	0.11
		26	Noland	0.09	0.06	0.06	0.05	0.06	0.25	0.24	0.12
Region Mean				0.08	0.06	0.09	0.05	0.06	0.2	0.26	0.12
Thunder Bay (7)	48° 30'	2	Belluz	0.11	0.20	0.13	0.13	0.13	0.19	0.23	0.16
		3	Breukelman	0.05	0.12	0.23	0.11	0.16	0.22	0.39*	0.16
		4	Brink	0.08	0.09	0.07	0.15	0.09	0.11	0.1	0.10
		5	Farmer	0.05	0.08	0.10	0.07	0.13	0.14	0.2	0.11
		6	Hanna	0.08	0.07	0.05	0.10	0.08	0.10	0.09	0.08
		7	Meier	0.08	0.07	0.03	0.25	0.22	0.09	0.42*	0.17
		3	TBARS	0.05	0.12	0.23	0.11	0.17	0.24	0.28	0.17
Region Mean				0.07	0.11	0.12	0.13	0.14	0.16	0.24	0.14
New Liskeard (	47° 30'	30	NLARS	0.08	0.05		0.08		0.16	0.24	0.16
Sudbury (3)	46° 30'	22	Mailloux	0.12	0.07	0.12	0.13	0.08	0.2	0.09	0.12
		23	Rainville	0.16	0.06				0.09	0.33*	0.16
		24	Soenens	0.05	0.15	0.06	0.17	0.25	0.41*	0.49*	0.23
Region Mean				0.11	0.09	0.09	0.15	0.17	0.23	0.30	0.16
Rainy River (7)	48° 45'	9	Fisher	0.12	0.11	0.10	0.11	0.12	0.35*	0.50*	0.20
		10	Herod	0.16	0.16	0.11	0.09	0.18	0.38*	0.19	0.18
		12	Lamb	0.05	0.07	0.11		0.16	0.13	0.28	0.13
		15	Lowey	0.09	0.10	0.16		0.15	0.18	0.20	0.16
		14	Peters	0.15	0.30	0.21	0.24	0.26	0.27	0.28	0.24
		16	Vandebrand	0.12	0.12	0.15	0.09	0.36*	0.30	0.32*	0.21
		32	EARS	0.05	0.05	0.06	0.07	0.10	0.10	0.17	0.08
Region Mean				0.11	0.13	0.13	0.13	0.16	0.24	0.29	0.17

Table 4

Summary of % THC values for industrial hemp varieties grown in northern and northwestern Ontario in 1998 over 30 sites in eight regions. Varieties and regions are ranked from lowest to highest for % THC values.

Samples for THC analysis were harvested at 50% of pollen shed 80-90 days post seeding.

				Varieties							
Region	Latitude	Site	Cooperator	Felina 34	Fedrina 74	Kompolti	Fedora 19	Unico-B	Irene	Secuieni 1	Site Mean
Kapuskasing (1)	49° 30'	29	KARS	0.07	0.08	0.05	0.13	0.05	0.05	0.05	0.07
Verner (3)	46° 30'	27	Brouillitte	0.05	0.10	0.05	0.12	0.09	0.08	0.10	0.08
		28	Olivier	0.05	0.05	0.07	0.09	0.07	0.10	0.16	0.07
		31	VARS	0.03	0.08	0.06	0.05	0.07	0.05	0.21	0.08
Region Mean				0.04	0.08	0.06	0.09	0.08	0.08	0.16	0.07
Dryden (5)	49° 45'	17	Brunner	0.05	0.05	0.05	0.08	0.07	0.09	0.23	0.09
		18	Ingebrigsten	0.05	0.06	0.07	0.05	0.05	0.07	0.08	0.06
		19	Jackson-1	0.07	0.07	0.05	0.07		0.05	0.11	0.07
		19	Jackson-2	0.14	0.09	0.06	0.12	0.05	0.2	0.28	0.13
		20	McRae	0.16	0.16	0.13	0.20	0.14	0.34*	0.53*	0.22
		21	Parker	0.06	0.06	0.08	0.16	0.08	0.19	0.16	0.11
Region Mean				0.09	0.08	0.07	0.11	0.08	0.16	0.23	0.10
Manitoulin (2)	45° 30'	25	Lecuyer	0.07	0.05	0.12	0.05	0.10	0.14	0.27	0.11
		26	Noland	0.09	0.06	0.06	0.05	0.08	0.25	0.24	0.12
Region Mean				0.08	0.06	0.09	0.05	0.09	0.2	0.26	0.12
Thunder Bay (7)	48° 30'	2	Belluz	0.11	0.20	0.13	0.13	0.13	0.19	0.23	0.16
		3	Breukelman	0.05	0.12	0.23	0.11	0.16	0.22	0.39*	0.18
		4	Brink	0.08	0.09	0.07	0.15	0.09	0.11	0.1	0.10
		5	Farmer	0.05	0.08	0.10	0.07	0.13	0.14	0.2	0.11
		6	Hanna	0.08	0.07	0.05	0.10	0.06	0.10	0.09	0.08
		7	Meier	0.08	0.07	0.03	0.25	0.22	0.09	0.42*	0.17
		3	TBARS	0.05	0.12	0.23	0.11	0.17	0.24	0.28	0.17
Region Mean				0.07	0.11	0.12	0.13	0.14	0.16	0.24	0.14
New Liskeard (	47° 30'	30	NLARS	0.09	0.05		0.09		0.16	0.34*	0.15
Sudbury (3)	46° 30'	22	Mallous	0.12	0.07	0.12	0.13	0.08	0.2	0.09	0.12
		23	Rainville	0.16	0.06				0.09	0.33*	0.16
		24	Soenens	0.05	0.15	0.06	0.17	0.25	0.41*	0.49*	0.23
Region Mean				0.11	0.09	0.09	0.15	0.17	0.23	0.30	0.16
Rainy River (7)	48° 45'	9	Fisher	0.12	0.11	0.10	0.11	0.12	0.35*	0.50*	0.20
		10	Herod	0.18	0.18	0.11	0.09	0.18	0.38*	0.19	0.18
		12	Lamb	0.05	0.07	0.11		0.16	0.13	0.28	0.13
		15	Lowey	0.09	0.10	0.16		0.15	0.18	0.20	0.15
		14	Peters	0.15	0.30	0.21	0.24	0.26	0.27	0.28	0.24
		16	Vandebrand	0.12	0.12	0.15	0.09	0.36*	0.30	0.32*	0.21
		32	EARS	0.05	0.05	0.06	0.07	0.10	0.10	0.17	0.09
Region Mean				0.11	0.13	0.13	0.12	0.19	0.24	0.28	0.17

Table 5

Summary of % THC values for industrial hemp varieties grown in southern Ontario and southwestern Quebec in 1998. Samples for THC analysis were harvested at 50% pollen shed.

Region	Latitude	Variety	N	Mean	Low	High	Sd	>0.3%
London	43 º 0'	Unico-B	16	0.17	0.07	0.26	0.043	0/16
Chatham	42 º 25'	Unico-B	13	0.12	0.04	0.26	0.06	0/16
		Kompolti	1	0.08				0/1
		Fedora 19	8	0.18	0.04	0.34	0.096	1/8
		Ferimon	4	0.11	0.04	0.15	0.048	0/4
		Felina 34	5	0.08	0.07	0.09	0.011	0/5
		Futura	3	0.12	0.06	0.16	0.055	0/3
		Fedrina 74	6	0.17	0.08	0.30	0.098	0/6
		Secuieni 1	21	0.32	0.18	0.53	0.096	8/21
		Irene	1	0.41				1/1
Region Mean				**0.19**				
Ottawa Valley	45 º 0'	Secuieni 1	2	0.14	0.14	0.14		0/2
		Unico-B	1	0.17				0/1
Region Mean				**0.16**				
Southwest Quebec	45 º 30'	Unico-B	1	0.13				0/1
		Felina 34	1	0.11				0/1
		Secuieni 1	1	0.22				0/1
Region Mean				**0.17**				
Leamington (sand mixed with clay)	42 º 0'	Futura	1	0.12				
		Fedora 19	1	0.07				
		Secuieni 1	1	0.05				
		Irene	1	0.16				
		Kompolti	1	0.10				
		Unico-B	1	0.11				

Region Mean				**0.101**				
St. Joachim (Brookston clay)	42 ° 0'	Futura	1	0.07				
		Fedora 19	1	0.12				
		Secuieni 1	1	0.13				
		Irene	1	0.31				
		Kompolti	1	0.19				
		Unico-B	1	0.24				
Region Mean				**0.176**				
Chatham*		Secuieni 1	18	0.23	0.103	0.395	0.092	4/18
* THC samples harvested 50 days after emergence								

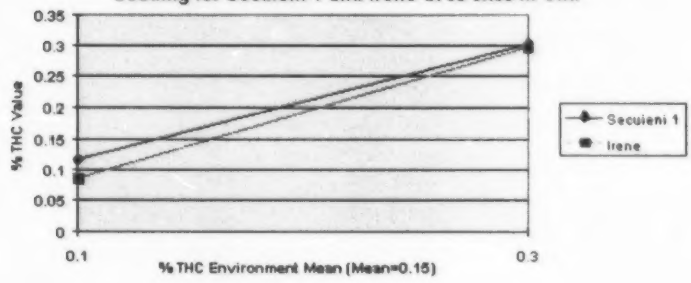
Table 6

Summary of Average % THC over 14 Regions of Ontario and Southwest Quebec from samples harvested 80 to 90 days post seeding (50 % pollen shed)

		Variety							
Region	**Latitude**	**Felina 34**	**Fedrina 74**	**Kompolti**	**Fedora 19**	**Uniko-B**	**Irene**	**Secuieni 1**	**Region Mean**
Verner	46 ° 30'	0.05	0.08	0.06	0.09	0.08	0.08	0.16	0.07
Kapuskasing	49 ° 30'	0.07	0.08	0.05	0.13	0.05	0.05	0.05	0.07
Leamington	42 ° 0'	n/a	n/a	0.1	0.07	0.11	0.16	0.05	0.1
Dryden/ Kenora	49 ° 95'	0.09	0.08	0.07	0.11	0.08	0.16	0.23	0.1
Manitoulin Island	45 ° 50'	0.08	0.06	0.09	0.05	0.09	0.2	0.26	0.12
Thunder Bay	48 ° 30'	0.07	0.11	0.12	0.13	0.14	0.16	0.24	0.14
New Liskeard	47 ° 30'	0.09	0.05	n/a	0.09	n/a	0.16	0.34*	0.15
Ottawa Valley	45 ° 0'	n/a	n/a	n/a	n/a	0.17	n/a	0.14	0.16
Sudbury	46 ° 30'	0.11	0.09	0.09	0.15	0.17	0.23	0.3	0.16
London	43 ° 0'	n/a	n/a	n/a	n/a	0.17	n/a	n/a	0.17
Southwest Quebec	45 ° 30'	0.11	n/a	n/a	n/a	n/a	n/a	0.22	0.17
Rainy River	48 ° 95'	0.11	0.13	0.13	0.12	0.19	0.24	0.28	0.17
Chatham	42 ° 25'	0.08	0.17	0.08	0.18	0.11	0.41	0.32*	0.19
St. Joachim	42 ° 0'	n/a	n/a	0.19	0.12	0.24	0.31*	0.13	0.2

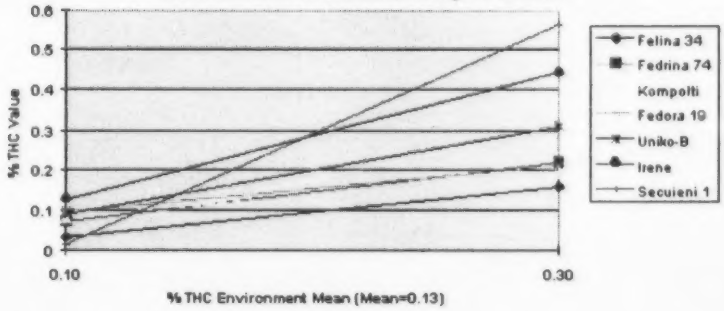
Overall Mean	0.09	0.09	0.09	0.11	0.13	0.2	0.21	0.14
Range	0.05-0.11	0.05-0.17	0.05-0.19	0.05-0.18	0.05	0.24	0.05-0.31	0.05-0.34
* Regions where average % THC exceeded 0.3 % level								

Graph #1 : Regression Analysis of % THC 50 Days post Seeding for Secuieni 1 and Irene at 30 sites in Ont.

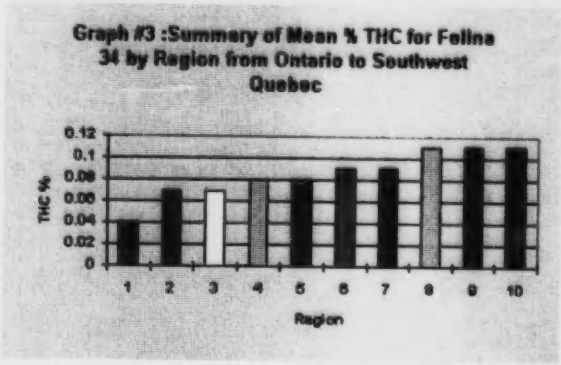


Variety	N	Mean	Slope	r	R^2
Secuieni 1	30	0.17	0.936	87.2	76
Irene	30	0.14	1.064	89.6	80.4

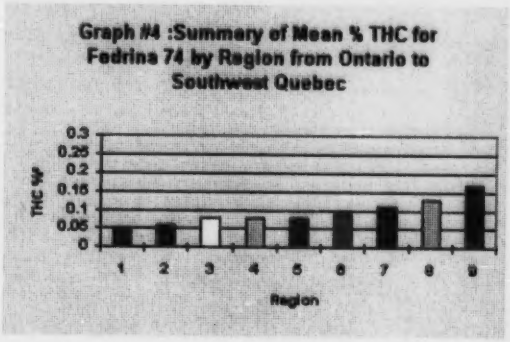
Graph #2 :Regression of % THC 80-90 Days post Seeding for seven varieties of industrial hemp in Ontario



Variety	N	Mean	Slope	r	R^2
Felina 34	30	0.081	0.442	59.4	35.3
Fedrina 74	30	0.084	0.738	72.6	52.6
Kompolti	27	0.086	0.563	55.0	30.2
Fedora 19	27	0.109	0.569	59.3	35.2
Uniko-B	27	0.113	1.095	79.5	63.1
Irene	30	0.158	1.600	82.5	68.1
Secuieni 1	30	0.231	1.900	77.8	60.5

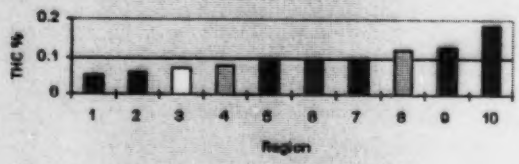


	Felina 34				
	Region	THC %	# of Sites	Low THC %	High THC %
1	Verner	0.04	3	0.03	0.05
2	Thunder Bay	0.07	7	0.05	0.11
3	Kapuskasing	0.07	1	n/a	n/a
4	Chatham	0.08	5	0.07	0.09
5	Manitoulin Island	0.08	2	0.07	0.09
6	Dryden/Kenora	0.09	6	0.05	0.16
7	New Liskeard	0.09	1	n/a	n/a
8	Southwest Quebec	0.11	1	n/a	n/a
9	Sudbury	0.11	3	0.05	0.16
10	Rainy River	0.11	7	0.05	0.16
*Max. legal limit is 0.3%					



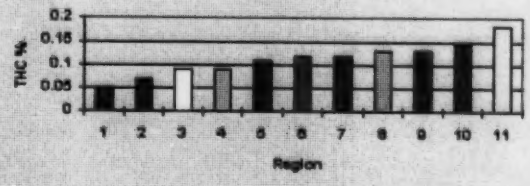
Fedrina 74					
	Region	THC %	# of Sites	Low THC %	High THC %
1	New Liskeard	0.05	1	n/a	n/a
2	Manitoulin Island	0.06	2	0.05	0.06
3	Dryden/Kenora	0.08	5	0.05	0.16
4	Verner	0.08	3	0.05	0.10
5	Kapuskasing	0.08	1	n/a	n/a
6	Sudbury	0.09	3	0.07	0.15
7	Thunder Bay	0.11	7	0.07	0.20
8	Rainy River	0.13	7	0.05	0.30
9	Chatham	0.17	6	0.08	0.30

Graph #5 :Summary of Mean % THC for Kompolti by Region from Ontario to Southwest Quebec

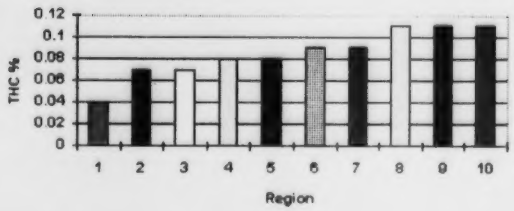


		Kompolti			
	Region	THC %	# of sites	Low THC %	High THC %
1	Kapuskasing	0.05	1	n/a	n/a
2	Verner	0.06	3	0.05	0.07
3	Dryden/Kenora	0.07	6	0.05	0.13
4	Chatham	0.08	1	n/a	n/a
5	Manitoulin Island	0.09	2	0.06	0.12
6	Sudbury	0.09	3	0.06	0.12
7	Leamington	0.10	1	n/a	n/a
8	Thunder Bay	0.12	7	0.03	0.23
9	Rainy River	0.13	7	0.06	0.21
10	St. Joachim	0.19	1	n/a	n/a

Graph #6 :Summary of Mean % THC for Fedora19 by Region from Ontario to Southwest Quebec

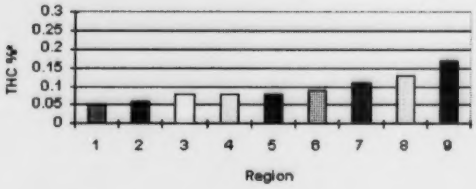


Graph #3 :Summary of Mean % THC for Felina 34 by Region from Ontario to Southwest Quebec



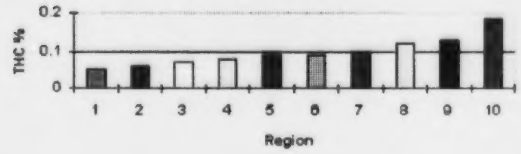
	Felina 34				
	Region	**THC %**	**# of Sites**	**Low THC %**	**High THC %**
1	Verner	0.04	3	0.03	0.05
2	Thunder Bay	0.07	7	0.05	0.11
3	Kapuskasing	0.07	1	n/a	n/a
4	Chatham	0.08	5	0.07	0.09
5	Manitoulin Island	0.08	2	0.07	0.09
6	Dryden/Kenora	0.09	6	0.05	0.16
7	New Liskeard	0.09	1	n/a	n/a
8	Southwest Quebec	0.11	1	n/a	n/a
9	Sudbury	0.11	3	0.05	0.16
10	Rainy River	0.11	7	0.05	0.16
*Max. legal limit is 0.3%					

Graph #4 :Summary of Mean % THC for Fedrina 74 by Region from Ontario to Southwest Quebec



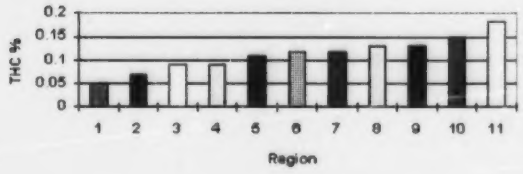
Fedrina 74					
	Region	**THC %**	**# of Sites**	**Low THC %**	**High THC %**
1	New Liskeard	0.05	1	n/a	n/a
2	Manitoulin Island	0.06	2	0.05	0.06
3	Dryden/Kenora	0.08	5	0.05	0.16
4	Verner	0.08	3	0.05	0.10
5	Kapuskasing	0.08	1	n/a	n/a
6	Sudbury	0.09	3	0.07	0.15
7	Thunder Bay	0.11	7	0.07	0.20
8	Rainy River	0.13	7	0.05	0.30
9	Chatham	0.17	6	0.08	0.30

Graph #5 :Summary of Mean % THC for Kompolti by Region from Ontario to Southwest Quebec



		Kompolti			
	Region	**THC %**	**# of sites**	**Low THC %**	**High THC %**
1	Kapuskasing	0.05	1	n/a	n/a
2	Verner	0.06	3	0.05	0.07
3	Dryden/Kenora	0.07	6	0.05	0.13
4	Chatham	0.08	1	n/a	n/a
5	Manitoulin Island	0.09	2	0.06	0.12
6	Sudbury	0.09	3	0.06	0.12
7	Leamington	0.10	1	n/a	n/a
8	Thunder Bay	0.12	7	0.03	0.23
9	Rainy River	0.13	7	0.06	0.21
10	St. Joachim	0.19	1	n/a	n/a

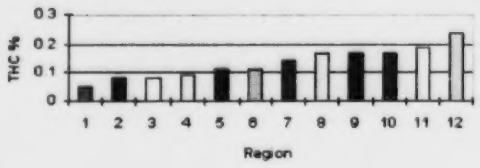
Graph #6 :Summary of Mean % THC for Fedora19 by Region from Ontario to Southwest Quebec



Fedora 19

	Region	THC %	# of Sites	Low THC %	High THC %
1	Manitoulin Island	0.05	2	0.05	0.05
2	Leamington	0.07	1	n/a	n/a
3	Verner	0.09	3	0.05	0.12
4	New Liskeard	0.09	1	n/a	n/a
5	Dryden/Kenora	0.11	6	0.05	0.20
6	St. Joachim	0.12	1	n/a	n/a
7	Rainy River	0.12	7	0.07	0.24
8	Thunder Bay	0.13	7	0.07	0.25
9	Kapuskasing	0.13	1	n/a	n/a
10	Sudbury	0.15	3	0.13	0.17
11	Chatham	0.18	8	0.04	0.34

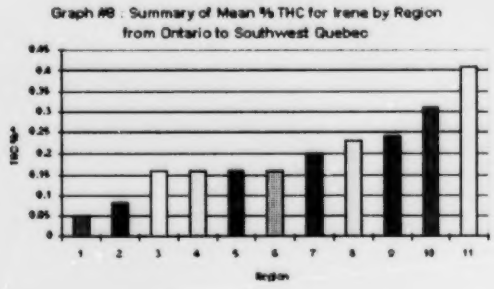
Graph #7 :Summary of Mean % THC for Uniko-B by Region from Ontario to Southwest Quebec



Uniko-B

	Region	THC %	# of Sites	Low THC %	High THC %
1	Kapuskasing	0.05	1	n/a	n/a
2	Dryden/Kenora	0.08	6	0.05	0.14
3	Verner	0.08	3	0.07	0.09
4	Manitoulin Island	0.09	2	0.08	0.10
5	Chatham	0.11	13	0.04	0.26
6	Leamington	0.11	1	n/a	n/a
7	Thunder Bay	0.14	7	0.06	0.22
8	London	0.17	16	0.07	0.26
9	Ottawa Valley	0.17	1	n/a	n/a
10	Sudbury	0.17	3	0.08	0.25
11	Rainy River	0.19	7	0.10	0.36
12	St. Joachim	0.24	1	n/a	n/a

*Max. legal limit is 0.3%

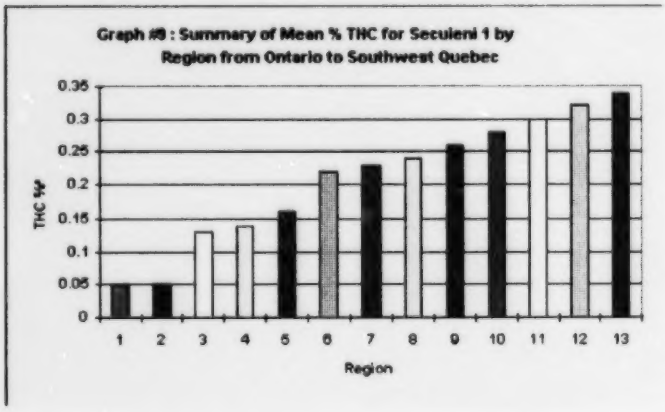


Irene

	Region	THC %	# of Sites	Low THC %	High THC %
1	Kapuskasing	0.05	1	n/a	n/a
2	Verner	0.08	3	0.05	0.10
3	Leamington	0.16	1	n/a	n/a
4	Thunder Bay	0.16	7	0.09	0.24
5	Dryden/Kenora	0.16	6	0.05	0.34*
6	New Liskeard	0.16	1	n/a	n/a
7	Manitoulin Island	0.20	2	0.14	0.25
8	Sudbury	0.23	3	0.09	0.41*
9	Rainy River	0.24	7	0.10	0.38*
10	St. Joachim	0.31	1	n/a	n/a
11	Chatham	0.41	1	n/a	n/a

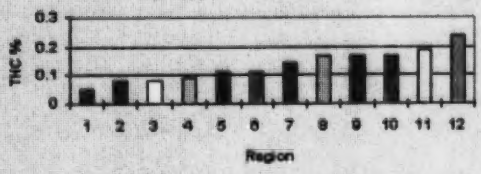
*Max. legal limit is 0.3%

*% THC levels exceed 0.3 %



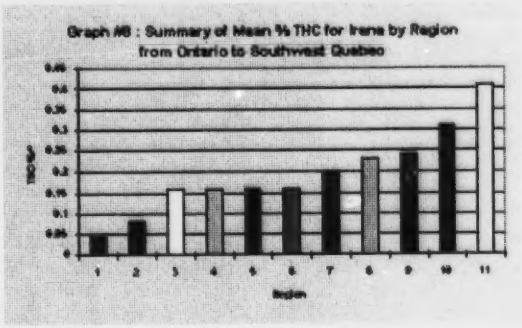
		Fedora 19			
	Region	THC %	# of Sites	Low THC %	High THC %
1	Manitoulin Island	0.05	2	0.05	0.05
2	Leamington	0.07	1	n/a	n/a
3	Verner	0.09	3	0.05	0.12
4	New Liskeard	0.09	1	n/a	n/a
5	Dryden/Kenora	0.11	6	0.05	0.20
6	St. Joachim	0.12	1	n/a	n/a
7	Rainy River	0.12	7	0.07	0.24
8	Thunder Bay	0.13	7	0.07	0.25
9	Kapuskasing	0.13	1	n/a	n/a
10	Sudbury	0.15	3	0.13	0.17
11	Chatham	0.18	8	0.04	0.34

Graph #7 :Summary of Mean % THC for Uniko-B by Region from Ontario to Southwest Quebec

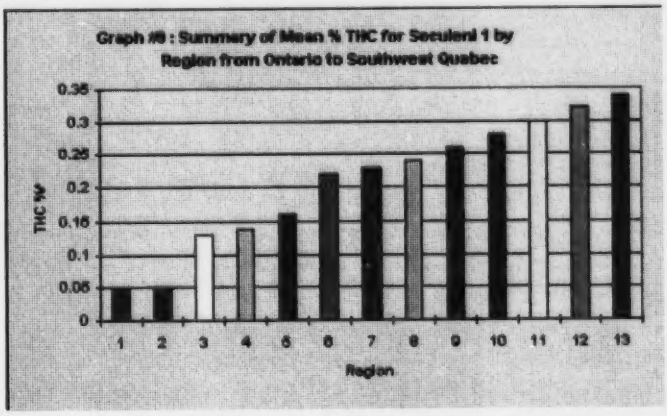


		Uniko-B			
	Region	THC %	# of Sites	Low THC %	High THC %
1	Kapuskasing	0.05	1	n/a	n/a
2	Dryden/Kenora	0.08	6	0.05	0.14
3	Verner	0.08	3	0.07	0.09
4	Manitoulin Island	0.09	2	0.08	0.10
5	Chatham	0.11	13	0.04	0.26
6	Leamington	0.11	1	n/a	n/a
7	Thunder Bay	0.14	7	0.06	0.22
8	London	0.17	16	0.07	0.26
9	Ottawa Valley	0.17	1	n/a	n/a
10	Sudbury	0.17	3	0.08	0.25
11	Rainy River	0.19	7	0.10	0.36
12	St. Joachim	0.24	1	n/a	n/a

*Max. legal limit is 0.3%

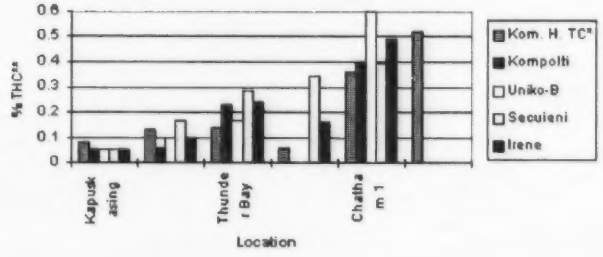


	Irene				
	Region	THC %	# of Sites	Low THC %	High THC %
1	Kapuskasing	0.05	1	n/a	n/a
2	Verner	0.08	3	0.05	0.10
3	Leamington	0.16	1	n/a	n/a
4	Thunder Bay	0.16	7	0.09	0.24
5	Dryden/Kenora	0.16	6	0.05	0.34*
6	New Liskeard	0.16	1	n/a	n/a
7	Manitoulin Island	0.20	2	0.14	0.25
8	Sudbury	0.23	3	0.09	0.41*
9	Rainy River	0.24	7	0.10	0.38*
10	St. Joachim	0.31	1	n/a	n/a
11	Chatham	0.41	1	n/a	n/a
	*Max. legal limit is 0.3%		*% THC levels exceed 0.3 %		



		Secuieni 1			
	Region	THC %	# of Sites	Low THC %	High THC %
1	Leamington	0.05	1	n/a	n/a
2	Kapuskasing	0.05	1	n/a	n/a
3	St. Joachim	0.13	1	n/a	n/a
4	Ottawa Valley	0.14	2	0.14	0.14
5	Verner	0.16	3	0.10	0.21
6	Southwest Quebec	0.22	1	n/a	n/a
7	Dryden/Kenora	0.23	6	0.08	0.53*
8	Thunder Bay	0.24	7	0.10	0.42*
9	Manitoulin Island	0.26	2	0.24	0.27
10	Rainy River	0.28	7	0.17	0.5*
11	Sudbury	0.30	3	0.09	0.49*
12	Chatham	0.32	21	0.18	0.53*
13	New Liskeard	0.34	1	n/a	n/a
			*% THC levels exceed 0.3 %		

Graph #10 : Summary of Latitude Effect on THC Levels of 4 Industrial Hemp Varities compared to Kompolti Hybrid TC in Ontario



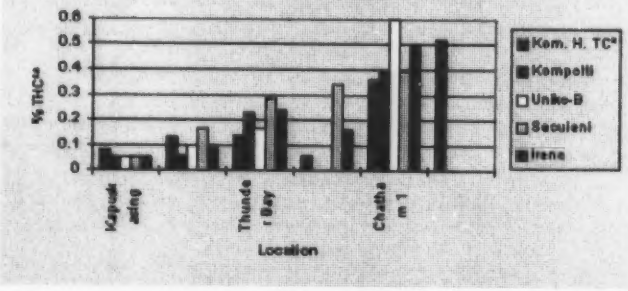
				** Max. Legal limit is 0.3 % THC		
				% THC		
Location	Latitude	Kom. H. TC*	Kompolti	Uniko-B	Secuieni	Irene
Kapuskasing	49 30'	0.08	0.05	0.05	0.05	0.05
Emo	48 45'	0.13	0.06	0.10	0.17	0.10
Thunder Bay	48 30'	0.14	0.23	0.17	0.29	0.24
New Liskeard	47 30'	0.06	n/a	n/a	0.34	0.16
Chatham 1	42 25'	0.36	0.40	0.6	0.39	0.49
Chatham 2	42 25'	0.52	n/a	n/a	n/a	n/a
	*Kompolti Hybrid TC					

| Top of Page |

This Infosheet was authored by: Gordon Scheifele (Thunder Bay), Herb Hinz(Thunder Bay), Karen Davies (Thunder Bay), Kim-Jo Bliss Calder (Emo), Matt Bowman (New Liskeard), Kemptville College/University of

		Secuieni 1			
	Region	THC %	# of Sites	Low THC %	High THC %
1	Leamington	0.05	1	n/a	n/a
2	Kapuskasing	0.05	1	n/a	n/a
3	St. Joachim	0.13	1	n/a	n/a
4	Ottawa Valley	0.14	2	0.14	0.14
5	Verner	0.16	3	0.10	0.21
6	Southwest Quebec	0.22	1	n/a	n/a
7	Dryden/Kenora	0.23	6	0.08	0.53*
8	Thunder Bay	0.24	7	0.10	0.42*
9	Manitoulin Island	0.26	2	0.24	0.27
10	Rainy River	0.28	7	0.17	0.5*
11	Sudbury	0.30	3	0.09	0.49*
12	Chatham	0.32	21	0.18	0.53*
13	New Liskeard	0.34	1	n/a	n/a
			*% THC levels exceed 0.3 %		

Graph #10 : Summary of Latitude Effect on THC Levels of 4 Industrial Hemp Varities compared to Kompolti Hybrid TC in Ontario



				** Max. Legal limit is 0.3 % THC		
				% THC		
Location	Latitude	Kom. H. TC*	Kompolti	Uniko-B	Secuieni	Irene
Kapuskasing	49 30'	0.08	0.05	0.05	0.05	0.05
Emo	48 45'	0.13	0.06	0.10	0.17	0.10
Thunder Bay	48 30'	0.14	0.23	0.17	0.29	0.24
New Liskeard	47 30'	0.06	n/a	n/a	0.34	0.16
Chatham 1	42 25'	0.36	0.40	0.6	0.39	0.49
Chatham 2	42 25'	0.52	n/a	n/a	n/a	n/a
	*Kompolti Hybrid TC					

| Top of Page |

This Infosheet was authored by: Gordon Scheifele (Thunder Bay), Herb Hinz(Thunder Bay), Karen Davies (Thunder Bay), Kim-Jo Bliss Calder (Emo), Matt Bowman (New Liskeard), Kemptville College/University of

Guelph, Thunder Bay Agricultural Research Station, Thunder Bay, Ontario. Laurier Guillemette, Kapuskasing Agriculture Research Station, Agriculture and Agri-Food Canada, Kapuskasing, Ontario.

For more information... regarding genetic stability of delta-9 THC for industrial hemp varieties contact Gordon Scheifele at: gscheife@omafra.gov.on.ca

| Top of Page |

| Crops Home Page |

| Central Site | Feedback | Search | Site Map | Français |
| Home | What's New | Calendar | Products | News Releases |

Ontario

This page maintained by the Government of Ontario

This information is provided as a public service, but we cannot guarantee that the information is current or accurate.
Readers should verify the information before acting on it.

Feedback and technical inquiries to: crops@omafra.gov.on.ca
©Copyright 2000 Queen's Printer for Ontario
Last Updated: March 9, 2000